

# PATENT SPECIFICATION

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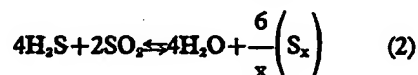
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## (54) A PROCESS FOR THE REMOVAL OF SULPHUR COMPOUNDS FROM CLAUS OFF-GASES

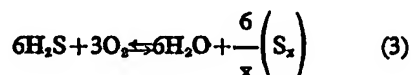
(71) We, SHELL INTERNATIONALE RESEARCH MAATSCHAPPIJ B.V., a company organised under the laws of The Netherlands, of 30 Carel van Bylandtlaan, The Hague, The Netherlands, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a process for the removal of sulphur compounds from Claus off-gases.

The process for the preparation of elemental sulphur from hydrogen sulphide by partial oxidation thereof by means of oxygen or an oxygen-containing gas such as air, followed by reaction of the sulphur dioxide formed from the hydrogen sulphide with the remaining part of the hydrogen sulphide in the presence of a catalyst is known as the Claus process. This process, which is frequently used both at refineries and for working up hydrogen sulphide recovered from natural gas, is carried out in a Claus plant comprising a combination chamber followed by one or more catalyst beds, one or more condensers being arranged in between which the reaction products are cooled and the separated liquid sulphur is recovered. The various process steps can be represented by the following reaction equations:



while the total reaction is represented by equation 3:



For temperatures below 500°C the symbol  $x$  in the above equation has a value of 8.

Since the yield of recovered elemental sulfur in respect of hydrogen sulphide introduced is not completely quantitative, a certain amount of unreacted hydrogen sulphide and sulphur dioxide is removed from the Claus process. These gases are normally incinerated in a furnace—during which process all hydrogen sulphide is converted to sulphur dioxide—and subsequently discharged into the atmosphere via a high stack. The amount of sulphur recovered depends to some extent on the total number of catalyst beds used in the Claus process. In theory, 98% of sulphur can be recovered when three beds are used. However, in practice the yield of sulphur is lower since carbonyl sulphide (COS) and carbon disulphide (CS<sub>2</sub>) are formed by side-reactions between hydrogen sulphide and hydrocarbons and/or carbon dioxide present in the feed. Sulphur losses also occur as the result of the formation of elemental sulphur vapour and/or mist.

Viewed in the light of the increasingly stringent requirements in respect of air pollution abatement, working up Claus off-gases in this way is less desirable. Moreover, it involves a certain loss in sulphur yield.

The total sulphur content of Claus off-gases can be reduced by adding a reducing gas to these off-gases and passing the resultant mixture over a catalyst which catalyses the reduction of sulphur and sulphur compounds, such as SO<sub>2</sub>, and in some cases also COS and CS<sub>2</sub>, to H<sub>2</sub>S. The resultant gas which should contain H<sub>2</sub>S as the only sulphur compound is cooled and the H<sub>2</sub>S is subsequently converted into elemental sulphur. Having regard to the provisions of Section 9 of the Patent Act, attention is drawn to the claims of our earlier-dated U.K. Patents Nos. 1,332,337, 1,356,289 and 1,409,436 in this respect.

Problems may arise if complete reduction of the sulphur compounds present in the Claus off-gas does not take place and if, for example,  $\text{SO}_2$  is still present therein since through reaction with  $\text{H}_2\text{S}$ , such  $\text{SO}_2$  may give rise to the formation of sulphur at undesirable locations and it may interfere with the conversion process of  $\text{H}_2\text{S}$  to sulphur, for example, by reaction occurring with absorption and/or reaction liquids used. Incomplete reduction of the sulphur compounds may, for example, occur if less than the required amount of reducing gas is added for the catalytic reduction.

The quantities of sulphur compounds, in particular  $\text{SO}_2$ , in Claus off-gases may vary during operation, for example, as the result of too large an air supply to the combustion chamber of the Claus plant, or of ageing of the catalysts in the Claus catalyst beds.

The present invention provides a process in which the supply of reducing gas to a Claus off-gas is adjusted in accordance with the amount of sulphur compound(s) therein.

According to the present invention there is provided a process for the removal of sulphur dioxide from a Claus off-gas, in which a reducing gas consisting of or containing free hydrogen or free hydrogen and free carbon monoxide or free carbon monoxide is added to the Claus off-gas, the resulting gas mixture is treated by passing it at a temperature in excess of  $175^\circ\text{C}$  over a sulphided Group VI metal and/or Group VIII metal catalyst supported on an inorganic oxidic carrier, the resulting treated gas mixture, which contains hydrogen sulphide, is cooled, at least partially by direct cooling with an aqueous liquid, to a temperature below the dew point of water at the prevailing pressure, and the hydrogen sulphide present in the resulting cooled gas mixture is converted into elemental sulphur, wherein the proportion of said reducing gas added to said Claus off-gas is controlled by (1) either (a) measuring the amount of hydrogen present in said treated gas mixture, either before or after the direct cooling thereof, or (b) measuring, after direct cooling, the amount of elemental sulphur formed in said aqueous liquid, (2) generating a signal proportional to the so-measured amount of hydrogen or elemental sulphur, and (3) utilising said signal to control the amount of said reducing gas added to the Claus off-gas so as to maintain either (a) at least a predetermined excess of hydrogen in said treated gas mixture or (b) at least a predetermined minimum amount of formed sulphur in said aqueous liquid, respectively.

A Claus off-gas is the gas obtained after the last catalyst bed of a Claus plant. It is customary to employ Claus processes in which use is made of two beds, but a third catalytic bed is regularly used as well. In

addition to hydrogen sulphide and sulphur dioxide in a ratio of approximately 2:1, Claus off-gases contain sulphur, nitrogen, water (as water vapour), hydrogen, carbon dioxide, carbon monoxide, small amounts of inert gases if the Claus plant is operated with air, and small amounts of carbonyl sulphide and carbon disulphide. In some cases hydrogen cyanide and/or ammonia may also be present.

After passing the last bed and the condenser for the recovery of elemental sulphur, the Claus off-gases normally have a temperature of from  $130^\circ\text{C}$  to  $170^\circ\text{C}$ . For the reduction stage over the Group VI metal/Group VIII metal Menedeleff Classification catalyst, however, the off-gases must have a higher temperature, and therefore these off-gases are heated to a temperature in excess of  $175^\circ\text{C}$ , which preferably is between  $180^\circ\text{C}$  and  $600^\circ\text{C}$ , and more preferably between  $200^\circ\text{C}$  and  $500^\circ\text{C}$ . Such increase in temperature above  $175^\circ\text{C}$  is also important in view of the presence of small amounts of elemental sulphur in the form of a mist or vapour in the off-gases. This objectionable sulphur mist disappears when the temperature is raised above the dew point of sulphur. It has also been found that as a result of raising the temperature to above  $175^\circ\text{C}$ , and preferably to above  $180^\circ\text{C}$ , the presence of elemental sulphur in the gas phase has no adverse effect on the catalytic activity of the reduction catalyst to be used.

The increase in temperature of the Claus off-gases may be achieved by external heating. It is preferred to heat the Claus off-gases to a temperature in excess of  $175^\circ\text{C}$  in a direct heating burner to which a fuel and an oxygen-containing gas are supplied. In a burner of this type a fuel is burnt in a burner section and the resultant combustion gases are mixed with the Claus off-gases to be heated in a mixing section of the direct heating burner.

The Claus off-gases are mixed with a reducing gas which may be added before or after heating to a temperature of at least  $175^\circ\text{C}$ . When making use of a direct heating burner the reducing gas is suitably supplied after the combustion of the fuel and before the mixing of the combustion gases with the Claus off-gases.

Preferably, the reducing gas contains both hydrogen and carbon monoxide. Very suitable reducing gases are town gas, water gas, synthesis gas, off-gas of a catalytic reforming unit, gas produced in a hydrogen plant or gas obtained from a working-up unit for saturated crude gases from petroleum. Pure hydrogen or carbon monoxide or mixtures thereof are also eligible for use. Preferably, a reducing gas which contains at least 5%, by volume, of  $\text{H}_2$ , or an equivalent amount of hydrogen

and carbon monoxide or an equivalent amount of carbon monoxide is used. Mixtures of hydrogen and carbon monoxide which contain the said compounds in a volume ratio of 10:1 to 1:9 have been found to be particularly suitable. When using mixtures of hydrogen and carbon monoxide, higher space velocities can be used for the same degree of conversion of the reducing agent than when using hydrogen per se. This is due to the fact that in the presence of carbon monoxide the reaction rate for the reduction of the sulphur compounds in the Claus off-gas increases. The hydrogen or the hydrogen-containing gas is used in such a quantity that the ratio between hydrogen and/or carbon monoxide and sulphur dioxide is between 3:1 to 15:1. This ratio is preferably between 3.5:1 and 8:1.

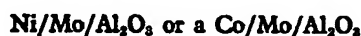
When use is made of direct heating burners for heating the Claus off-gases to the temperature required for the reduction, it is, however, also possible for the reducing gas to be produced by this heater. To this end preferably a light hydrocarbon (having at most 6 carbon atoms), such as methane, propane, butane or mixtures thereof, is burnt with a substoichiometric amount of air or oxygen. However, it is also possible to use liquid hydrocarbons such as naphtha, kerosine and gas oil for burners of this type. In this case a combustion gas is formed which contains hydrogen and carbon monoxide. It is desirable to produce no soot or a minimum thereof in this partial combustion in order to avoid clogging of the catalyst bed. The soot production and/or the combustion temperature can be further controlled by injecting water, steam or a mixture thereof into the combustion chamber of the direct heating burner during the combustion. As described above, the resultant combustion gases are mixed with the Claus off-gases in a mixing section.

As has been explained above, problems arise when the amount of reducing gas is not sufficient to reduce all the sulphur compounds present in the Claus off-gases to  $H_2S$ , and at such a moment the amount of reducing gas which is mixed with the Claus off-gases is adjusted, or increased, according to the invention.

When a direct heating burner is used for the production of the reducing gas, the amount of reducing gas is controlled by either increasing the supply of the feed to the burner or decreasing the oxygen supply, or the air supply, to the burner, or both.

After heating to a temperature in excess of  $175^\circ C$  the Claus off-gases, together with the reducing gas, are passed over a sulphided Group VI metal Group VIII metal catalyst in order to reduce the sulphur dioxide to hydrogen sulphide. At the same time elemental sulphur is converted to hydrogen

sulphide. The reduction catalysts used may be catalysts containing molybdenum, tungsten and/or chromium as Group VI metal, and preferably a metal from the iron group, such as cobalt, nickel and/or iron as Group VIII metal. The inorganic oxidic carrier may be alumina, silica, magnesia, boria, thorina, zirconia or a mixture of two or more of these compounds. Alumina is preferred. Suitable reduction catalysts for use in accordance with the process of the invention are a



catalyst.

The treatment of the off-gases with a free hydrogen—and/or free carbon monoxide-containing gas is preferably effected at a temperature in the range of from  $180^\circ C$  to  $600^\circ C$ , and more preferably between  $200^\circ C$  and  $500^\circ C$ . Although the pressure used is mainly atmospheric, slightly elevated pressures may also be used, if desired. The space velocity used during the reduction is from 500 to 10,000 NI of Claus off-gases per litre of catalyst per hour.

After the Claus off-gases have been passed, in the presence of a reducing gas, over the sulphided Group VI metal/Group VIII metal catalyst supported on an inorganic oxidic carrier, they are cooled. Although it is possible to carry out the entire cooling by direct contact with a cooling liquid consisting substantially or completely of water, it is preferred to carry out the cooling in two stages, external cooling being used in the first stage. During such external cooling (also called indirect cooling), water is very suitably used to coolant, which water may be converted during the cooling into low-pressure steam. Cooling in the first cooling stage is preferably carried out to a temperature of approximately  $140^\circ C$ – $180^\circ C$ .

In the second cooling stage, the gases are subsequently cooled by direct contact with a cooling liquid consisting substantially or completely of water, preferably to a temperature below  $50^\circ C$ . Water present in the gases is condensed and mixes with the cooling liquid. If in addition to  $H_2S$  the gases still contain  $SO_2$  (namely, if the reduction of the sulphur compounds in the Claus off-gases has not been complete), some sulphur will form which will render the liquid leaving the cooling unit somewhat turbid.

The amount of hydrogen present can be most suitably measured after the direct-cooling stage. The amount of hydrogen can, for example, be measured conductometrically and the resultant signal can be used to control the supply of reducing gas. As a rule the controller for the supply valve of the reducing gas will be set at a minimum value

because the presence of sulphur dioxide in the gases after the reduction stage is undesirable. A large excess of hydrogen is only undesirable for economic reasons, but a certain excess should be present after the reduction stage, in order to ensure at least that all sulphur compounds other than hydrogen sulphide have been reduced. The measuring signal may also be used to control the production of reducing gas when this is effected in the direct heating burner by means of partial combustion of light hydrocarbons as described above. To this end the measuring signal is passed to a controller which operates the supply valve of the feed and/or the oxygen or oxygen-containing gas to the burner, and compared therein with a set value.

The process may in theory also be governed on the presence of sulphur dioxide instead of hydrogen, but from the technical point of view it is in this case difficult to measure the sulphur dioxide since under normal operating conditions it is present in very small amounts of less than 10 parts per million by volume. In practice, therefore, the amount of hydrogen is measured since this gas component is present in larger quantities.

According to the invention it is also possible to determine the amount of sulphur formed in order to control the reducing gas. Within the scope of the invention the expression "the amount of sulphur" must be taken in its widest sense, in other words, the expression also includes magnitudes which are directly related to the amount of sulphur, for example the turbidity of an aqueous liquid containing sulphur.

The amount of sulphur may be determined in any desired manner; it is preferred to determine the turbidity of the cooling liquid. As soon as turbidity occurs, the amount of reducing gas which is mixed with the Claus off-gases is increased. Preferably, the observed indication of the sulphur content of the cooling liquid and the amount of reducing gas which is mixed with the Claus off-gases is coupled automatically. It will be clear that the control must be so set that in the absence of a small quantity of sulphur in the cooling liquid an amount of reducing gas is added to the Claus off-gases which, under normal operating conditions, is at least sufficient to convert the total amount of reducible sulphur compounds present in the Claus off-gases into  $H_2S$ , and it is preferred that the amount of reducing gas to be supplied to the Claus off-gases to be treated is, under normal operating conditions, slightly larger than that stoichiometrically required.

The cooling liquid which flows out of the cooling installation after the direct cooling can be re-used as cooling liquid after it has

been cooled. Since the amount of water in this cooling liquid increases as the result of condensation of water present in the Claus off-gases, some of the cooling liquid is often removed as a slip stream before recirculation. If desired, small amounts of  $H_2S$  present in the slip stream may be removed (for example by stripping) as well as any amounts of elemental sulphur present (by filtration).

It should be noted that the control of the supply of reducing gas by measuring the sulphur turbidity in the cooling water as described is usually less suitable in those cases in which the Claus off-gases also contain ammonia. As a result, the cooling water becomes weakly alkaline and if any sulphur dioxide is present in the gases (after reduction) thionates are formed in the cooling water and turbidity does not occur. Turbidity will only occur when the solution has been sufficiently acidified by continuous sulphur dioxide absorption. However, this requires an excessive period of time.

In this latter instance the sulphur measurement should be carried out on a slip stream of the cooling water by acidifying it under standardized conditions. Turbidity will then occur in the presence of sulphur compounds. However, it will be clear that process control by means of hydrogen measurement is to be preferred when ammonia is present in the Claus off-gas.

The gases leaving the direct cooling stage contain hydrogen sulphide which is converted into elemental sulphur. This may be effected in any suitable way, but advantageously by passing the gases through a liquid and regenerable absorbent, regenerating the hydrogen sulphide-enriched absorbent and supplying the hydrogen sulphide-rich gas mixture liberated during regeneration to a Claus plant (and preferably to the same Claus plant from which the treated Claus off-gases originate), as described in U.K. Patent Specification No. 1,356,289.

The hydrogen sulphide present in the gases which become available after the direct cooling may also very suitably be converted into sulphur by passing these gases to an alkaline water-containing solution in which at least some of the  $H_2S$  present in these gases is absorbed and in which solution the  $H_2S$  is converted into elemental sulphur with the aid of a catalyst. For this purpose the Stretford process is very suitable, wherein sodium vanadate and/or sodium ferrocyanide and/or sodium arsenate and/or sodium anthraquinone disulphonate and/or iron oxide and/or iodine are very suitable as catalyst. A mixture of sodium vanadate and sodium anthraquinone disulphonate is preferred. The basic substance in the alkaline water-containing solution is preferably an

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alkali metal carbonate, in particular sodium carbonate.

The alkaline water-containing solution is preferably continuously regenerated during the process by passing an oxygen-containing gas (e.g. air) therethrough.

The resultant sulphur may be separated in any suitable manner, for example, by filtration, floatation, centrifuging.

The part of the Claus off-gases which finally remains after the hydrogen sulphide has been converted into sulphur contains no sulphur compounds or only a very small amount thereof and may, if desired after combustion, be readily discharged to the atmosphere via a stack.

One embodiment of the process is represented in Fig. 1. The Claus off-gases are passed through a supply line 1 to a direct heating burner 5. Fuel is passed to this burner 5 through a line 2 and an oxygen-containing gas through a line 3. Hydrogen-containing gas is introduced into the direct heating burner through a line 4. The Claus off-gases, which have a temperature of approximately 150°C, are heated in the direct heating burner to a temperature of 225°C and are subsequently passed through a line 6 over a reduction catalyst in a reactor 7. All the hydrogen-containing gas required is supplied through the line 4. The reduced gases leave the reactor 7 through a line 8 and are cooled to a temperature below the dew point of water at the prevailing pressure in two stages, namely in a first stage in a heat exchanger 9 and in a second stage in a cooling column 10. In the cooling column 10 the gases flow countercurrently to the cooling water which is passed into the cooling column through a line 11. The cooling water and water formed by condensation of steam which was present in the off-gases leave the cooling column through a line 12. In the line 12 the degree of turbidity, which depends on the amount of sulphur present, is measured with the aid of a turbidity meter 31. The signal of this meter is passed to a controller 32, the output signal of which adjusts a control valve 33 in the supply line of the hydrogen-containing gas 4. In this controller the input signal is compared with a set value. If the liquid in the line 12 is clear, the supply of hydrogen-containing gas is maintained at a preset amount. All or some of the water leaving the cooling column 10 through the line 12 may, if desired, be recycled to the cooling column after filtration and/or stripping and/or cooling. The gases leave the cooling column through a line 13 and are passed into an absorber 14 which contains an aqueous solution of sodium carbonate, sodium vanadate and sodium anthraquinone disulphonate. The non-absorbed gases leave the absorber 14

through a line 15. They contain such a small amount of sulphur compounds that they may be readily discharged into the atmosphere, optionally after combustion.  $H_2S$  is absorbed in said aqueous solution which is passed through a line 16 into a regeneration reactor 17 into which oxygen-containing gas is supplied through a line 18. The contents of the reactor 17, which contains elemental sulphur, are discharged through a line 19 to a sulphur-separating unit 20 (e.g. a filter or a floatation unit), from which the elemental sulphur is discharged through a line 21. From the sulphur-separating unit 20 the aqueous solution is recycled to the absorber 14 through a line 22.

Another, more preferred embodiment of the process according to the invention is represented in Fig. 2. In this figure the part downstream of the direct cooling stage in cooling column 10 is not shown in the drawing. In the figure as shown, fuel is passed to a burner 5 through a line 2 which is provided with a control valve 36. An oxygen-containing gas is supplied through a line 3 which line is provided with a control valve 35. The reducing gas required for the reduction in a reactor 7 is produced by combustion of the fuel in the burner 5 using less than the stoichiometric proportion of combustion air. In order to be capable of controlling the substoichiometric combustion in respect of soot production, water, steam or a mixture thereof may be introduced through a line 39. The Claus off-gases are supplied to the burner through a line 1. After the reduction, the reduced gases are indirectly cooled in a heat exchanger 9 and subsequently cooled directly in a cooling column 10, as described above. After the direct cooling the hydrogen content of the gases in the line 13 is conductometrically measured by means of a meter 37. The signal leaving this meter is compared in a controller 38 with a set value applied via line 40. The controller 38 operates the valves 35 and 36. As soon as the measured value falls below the set value, the valves 35 and 36 are so adjusted that either more hydrogen is produced while the total volume of reducing gas remains the same or more reducing gas is produced at the same hydrogen content.

It will be clear that without departing from the scope of the invention, the process control as described above may, of course, also be effected by deriving a gas slip stream from the gas mixture after it leaves the reactor 7, cooling this slip stream to below the dew point of water at the pressure used, and measuring a sulphur turbidity, if any, of the resultant condensate. Another possibility comprises using the slip stream after cooling for the hydrogen measurement.

## WHAT WE CLAIM IS:—

1. A process for the removal of sulphur dioxide from a Claus off-gas, in which a reducing gas consisting of or containing free hydrogen or free hydrogen and free carbon monoxide or free carbon monoxide is added to the Claus off-gas, the resulting gas mixture is treated by passing it at a temperature in excess of 175°C over a sulphided Group VI metal and/or Group VIII metal catalyst supported on an inorganic oxidic carrier, the resulting treated gas mixture, which contains hydrogen sulphide, is cooled, at least partially by direct cooling with an aqueous liquid, to a temperature below the dew point of water at the prevailing pressure, and the hydrogen sulphide present in the resulting cooled gas mixture is converted into elemental sulphur, wherein the proportion of said reducing gas added to said Claus off-gas is controlled by (1) either (a) measuring the amount of hydrogen present in said treated gas mixture, either before or after the direct cooling thereof, or (b) measuring, after direct cooling, the amount of elemental sulphur formed in said aqueous liquid, (2) generating a signal proportional to the so-measured amount of hydrogen or elemental sulphur, and (3) utilising said signal to control the amount of said reducing gas added to the Claus off-gas so as to maintain either (a) at least a predetermined excess of hydrogen in said treated gas mixture or (b) at least a predetermined minimum amount of formed sulphur in said aqueous liquid, respectively.
2. A process as claimed in claim 1, wherein the Claus off-gases are heated to a temperature in excess of 175°C in a direct heating burner to which a fuel and an oxygen-containing gas are supplied.
3. A process as claimed in claim 2, wherein the reducing gas is introduced into the direct heating burner after the combustion of the fuel and before the mixing of the combustion gases thereof with the Claus off-gases.
4. A process as claimed in claim 2, wherein the reducing gas is produced in the direct heating burner by combustion of the fuel in the presence of less than the stoichiometric proportion of combustion air.
5. A process as claimed in claim 3 or 4, wherein water, steam or a mixture thereof is introduced into the combustion chamber of the direct heating burner during the combustion.
6. A process as claimed in any one of claims 2—5, wherein the fuel is a light hydrocarbon having at most 6 carbon atoms, or a mixture of such hydrocarbons.
7. A process as claimed in any one of claims 2—5, wherein the fuel is a liquid hydrocarbon.
8. A process as claimed in any one of the preceding claims, wherein Claus off-gases are passed over the sulphided catalyst at a temperature between 180°C and 600°C.
9. A process as claimed in claim 8, wherein the temperature is between 200°C and 500°C.
10. A process as claimed in any one of the preceding claims, wherein the catalyst contains cobalt and molybdenum.
11. A process as claimed in any one of the preceding claims, wherein the inorganic oxidic carrier is alumina.
12. A process as claimed in any one of the preceding claims, wherein the off-gases are passed over the sulphided catalyst at a space velocity of 500 to 10,000 NI per litre of catalyst per hour.
13. A process as claimed in any one of the preceding claims, wherein the mixture obtained after the reduction is cooled in two stages, indirect cooling being used in the first stage.
14. A process as claimed in claim 13, wherein the gases are cooled to a temperature between 140°C and 180°C in the first stage and to a temperature below 50°C in the second stage.
15. A process as claimed in any one of claims 1—14, wherein after the direct cooling the hydrogen is measured conductometrically.
16. A process as claimed in any one of claims 1—15, wherein the amount of elemental sulphur in the cooling liquid used in the direct cooling is determined by determining the turbidity of this cooling liquid.
17. A process as claimed in claim 15 or 16, wherein the resultant signal is passed to a controller which operates a control valve for the supply of the reducing gas to the direct heating burner.
18. A process as claimed in claim 15 or 16, wherein the resultant signal is passed to a controller which operates one or more control valves for the supply of fuel and/or an oxygen-containing gas to the direct heating burner.
19. A process as claimed in any one of the preceding claims, wherein after the direct cooling the hydrogen sulphide present in the gases is converted into sulphur by passing these cooled gases through a liquid and regenerable absorbent, regenerating the hydrogen sulphide-enriched absorbent and supplying the hydrogen sulphide-rich mixture liberated in the regeneration to a Claus plant.
20. A process as claimed in claim 19, wherein the said Claus plant is the Claus plant from which the treated Claus off-gases originate.
21. A process as claimed in any one of claims 1—18, wherein after the direct cooling the hydrogen sulphide present in the gases is converted into sulphur by passing these cooled gases to an alkaline water-containing solution in which at least some of the

H<sub>2</sub>S present in these gases is absorbed and in which solution the H<sub>2</sub>S is converted into elemental sulphur with the aid of a catalyst.

5 22. A process as claimed in claim 21, wherein the alkaline water-containing solution is a solution of an alkali metal carbonate.

23. A process as claimed in claim 22, wherein the alkali metal is sodium.

10 24. A process as claimed in any one of claims 21—23, wherein the catalyst present in the basic water-containing solution is sodium vanadate and/or sodium ferrocyanide and/or sodium arsenate and/or  
15 sodium anthraquinone disulphonate and/or iron oxide and/or iodine.

25. A process as claimed in claim 24, wherein the catalyst used is a mixture of sodium vanadate and sodium anthraquinone disulphonate.

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26. A process as claimed in claim 1 and substantially as described with reference to the figure 1 or figure 2 of the accompanying drawings.

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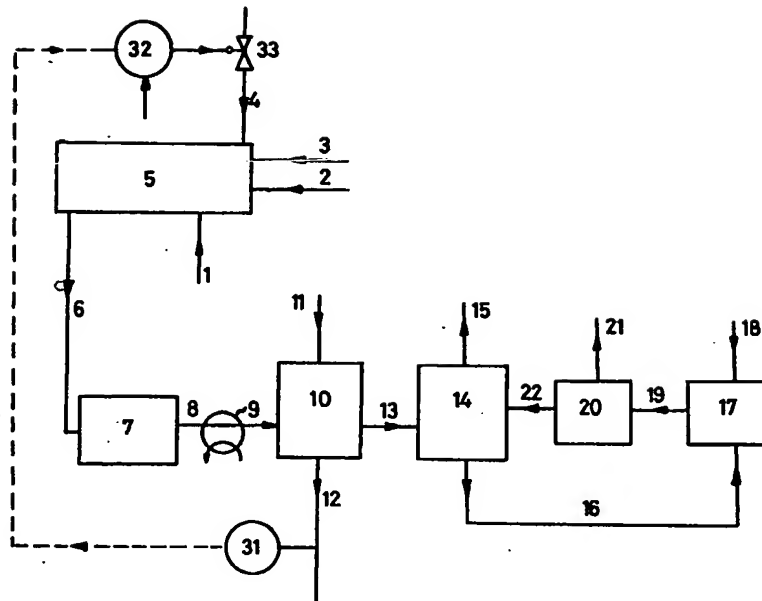


FIG. 1



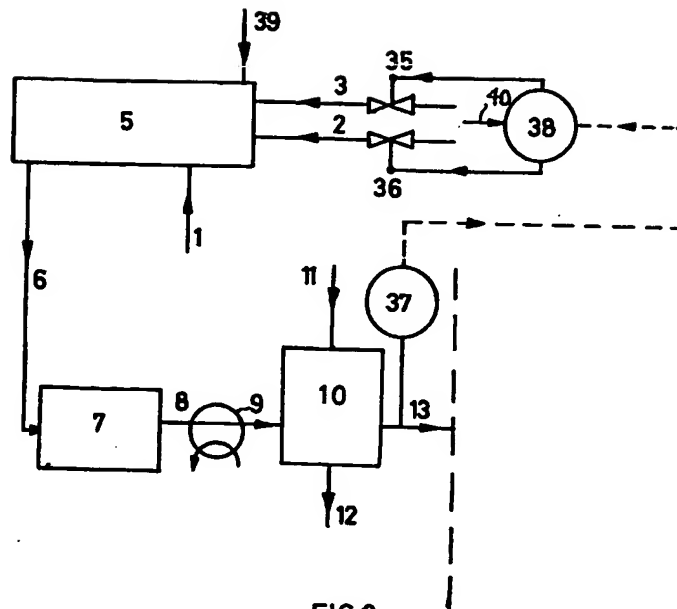


FIG. 2